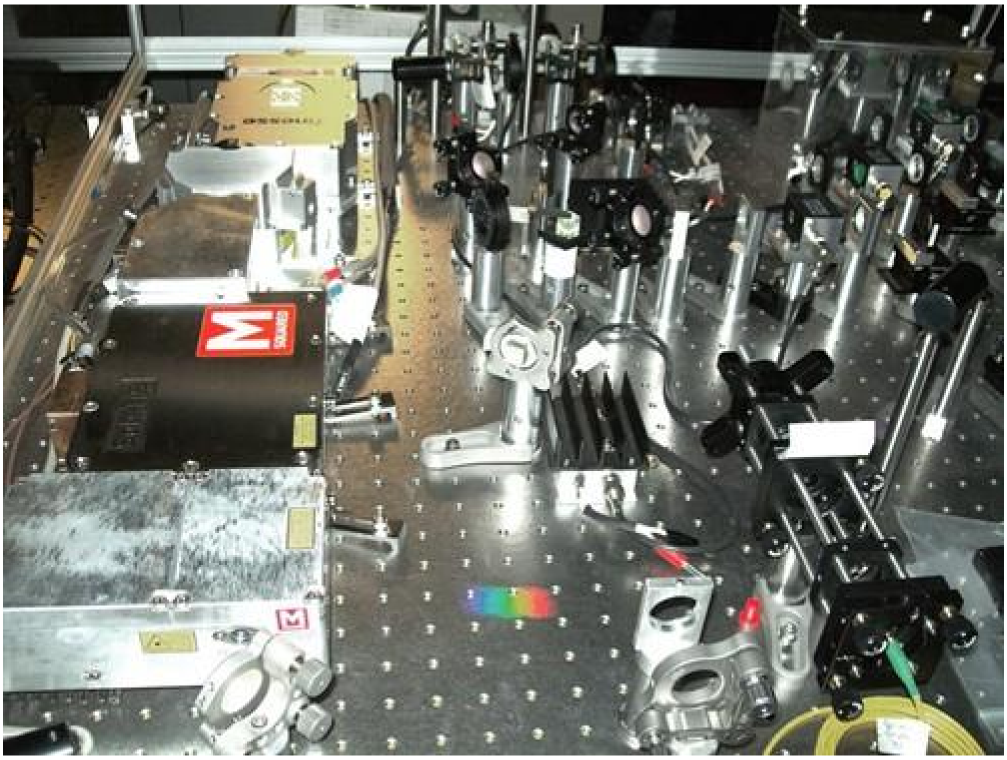
Bose-Einstein Condensates | Engels Group | WSU

The Engels Group at Washington State University employs a SolsTiS Ti Sapphire laser in their experiments with ultracold quantum gases. These experiments investigate spin-orbit coupling and artificial gauge fields in Bose-Einstein condensates (BECs) and quantum-degenerate Fermi gases (DFGs).



Two laser beams are derived from the output of the SolsTiS and shone into a UHV chamber from different directions, where they intersect at the position of a quantum degenerate cloud of atoms. The beams couple two atomic hyperfine states via a Raman transition. The laser geometry is chosen such that each time when an atom undergoes a Raman transition, it also receives a momentum kick caused by the momenta of the photons that are involved in the Raman process. This produces a coupling between the atomic hyperfine state, which can be considered as an artificial "pseudo spin", and the momentum of the atoms. A very analogous spin-orbit coupling plays a prominent role in condensed matter physics, where it leads to intriguing phenomena such as the spin-Hall effect, topological insulators, or Majorana fermions. Generating spin-orbit coupling in ultracold quantum gases offers the exciting prospect for studying the rich field of spin-orbit physics in a well-controlled environment that can be engineered almost at will using the rich toolbox of atomic physics.

Since the quantum gases used in these experiments are fragile objects that exist at temperatures on the order of merely 100 nK, care must be taken to minimize technical noise sources that otherwise would lead to a rapid heating of the atomic cloud and to the subsequent loss of quantum degeneracy. Dr. Engels says that the SolsTiS system has proven to be an excellent tool for this application.